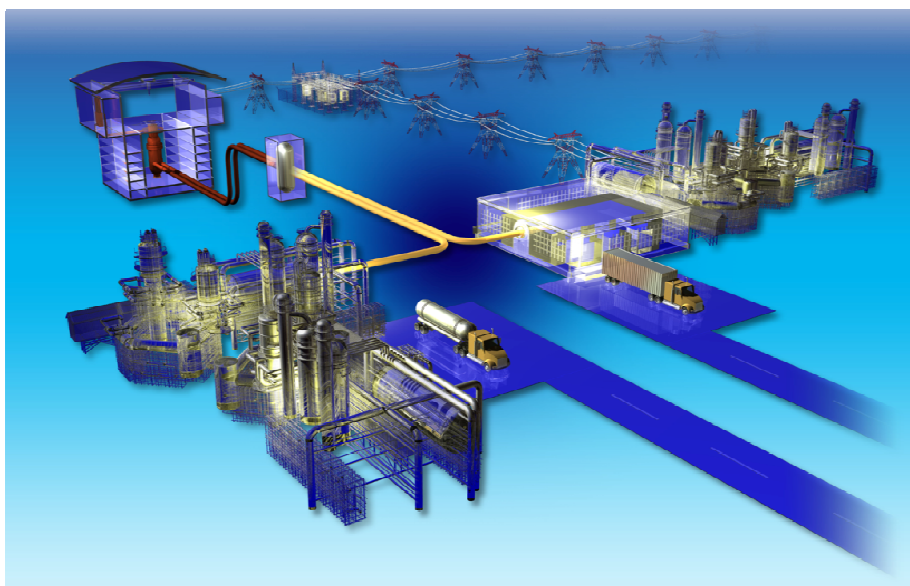


FY 2010 AGC-1 Disassembly Preparation

Philip Winston

September 2010

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**Prepared for the
U.S. Department of Energy
Office of Nuclear Energy
Under DOE Idaho Operations Office
Contract DE-AC07-05ID14517**

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Next Generation Nuclear Plant Project

FY 2010 AGC-1 Disassembly Preparation

INL/EXT-10-19758

September 2010

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September 2, 2010

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SUMMARY

The Next Generation Nuclear Plant Project Graphite Research and Development Program is currently establishing the safe operating envelope of graphite core components for a very high temperature reactor design. The program is generating quantitative data necessary for predicting the behavior and operating performance of the new nuclear graphite grades. To determine the in-service behavior of the graphite for pebble bed and prismatic designs, the Advanced Graphite Creep (AGC) experiment is underway. This experiment is examining the properties and behavior of nuclear grade graphite over a large spectrum of temperatures, neutron fluences, and compressive loads. Each experiment consists of over 400 graphite specimens that are characterized prior to irradiation and following irradiation. Six experiments are planned with the first, AGC-1, currently being irradiated in the Advanced Test Reactor. This report addresses progress to date in preparation for design and fabrication of disassembly tools for the AGC-1 experiment at the Materials Fuels Complex (MFC).

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FY 2010 AGC-1 Disassembly Preparation

1. INTRODUCTION

The Next Generation Nuclear Plant (NGNP) will be a high temperature gas-cooled reactor (HTGR) with a large graphite core. Graphite has been effectively used as both structural and moderator material in research as well as commercial HTGRs. While the general characteristics necessary for producing nuclear grade graphite are understood, historical nuclear grades no longer exist. New grades must therefore be fabricated, characterized, and irradiated to demonstrate that current grades of graphite exhibit acceptable irradiated and nonirradiated properties, upon which the thermomechanical design of the structural graphite in the NGNP is based.

The first Advanced Gas Creep experiment (AGC-1) is currently being irradiated in the Advanced Test Reactor (ATR) at the Idaho National Laboratory (INL). When it is removed from the reactor, the test train will be sectioned at the ATR and the graphite body and the remaining section of the pressure boundary will be shipped to Hot Fuels Examination Facility (HFEF) at the INL Materials and Fuels Complex (MFC) for further disassembly. The AGC-1 disassembly preparations started with an evaluation of the capabilities of the facilities that will be used to separate the graphite samples from the highly activated metal components.

2. INITIAL DESIGN DEVELOPMENT

Initial considerations addressed what operating envelope was acceptable and what location in the HFEF facility could accommodate this task. The original assumption was that the fine handling tasks of single sample identification and manipulation would be done in a glovebox at the Electron Microscopy Laboratory (EML) at MFC. As a result of review, it was concluded that moving the material to the Hot Repair Area (HRA) in the HFEF would eliminate the need for a facility-to-facility transfer of the sample material, which would be costly in terms of time and personnel exposure, requiring the samples to be bagged out of the HFEF, removed from the packaging in the EML, and repackaged for shipment to the INL Research Center (IRC).

In the planning process, a nominal step-by-step approach was developed in which the equipment and facility requirements were identified. The concerns noted were those of minimizing contamination of the graphite components and minimizing the amount of remote complexity and time manipulating components in the main cell. The design approach was to consider the possibility that the experiment will be easily separated from the activated components, but to assume that irradiation will affect the as-fabricated material in unanticipated ways that will require parting tools to cut the steel apart to free the graphite.

With those criteria in mind, an Engineering Job (EJ-276) was initiated to develop a general design that would utilize the capabilities of the operators and manual master-slave manipulators in the HFEF main cell for separating the steel from the graphite. An optional motorized mill head was considered for cutting the steel. The mill would be manually operated. Its power can be controlled with existing system wiring, with a control switch installed outside the cell. Positioning will be controlled by manually operated lead screws that are an integral part of the table. The advantage in using this approach is to minimize the need for a remotely operated motorized tool with multiple degrees of freedom that would require a complex and expensive feedthrough to provide operator control and communications.

To describe the task and the proposed design, a Technical Evaluation (TEV-829, "AGC-1 Disassembly In HFEF") was written to address the requirements and the experiment specifics as well as the proposed equipment approach. This document was reviewed and approved by HFEF personnel.

Three-dimensional scale drawings were developed to provide a basis for fabrication of the main basic component, which is the disassembly table. An overview sketch is shown as Figure 1. The basic disassembly table can be used with another computer-numerically-controlled mill that is installed at Window 11M of the HFEF main cell. This mill was installed for cutting Fast Flux Test Facility (FFTF) fuel. Due to the concern that detritus from the FFTF disassembly could contaminate the experiment, it was concluded that an independent mill head would be needed to reduce that possibility. The AGC table can be mounted on the FFTF mill, but a clean mill head used to allow all operations to be independent of FFTF activities has been incorporated into the design. The present configuration is to be installed at Window 10M.

Because a preference for removal of the center stack prior to cutting the graphite body into two was expressed, a design feature to allow this task to be performed was developed. A center stack receiver was developed to accept the multitude of small samples and spacers without removing the experiment component from the HFEF main cell.

Because the 12 thermocouples inserted into the graphite body are a source of activated metal, a special remote tool was designed to cut a countersink around the cut off thermocouple stub and provide a grip on the remainder for removal.

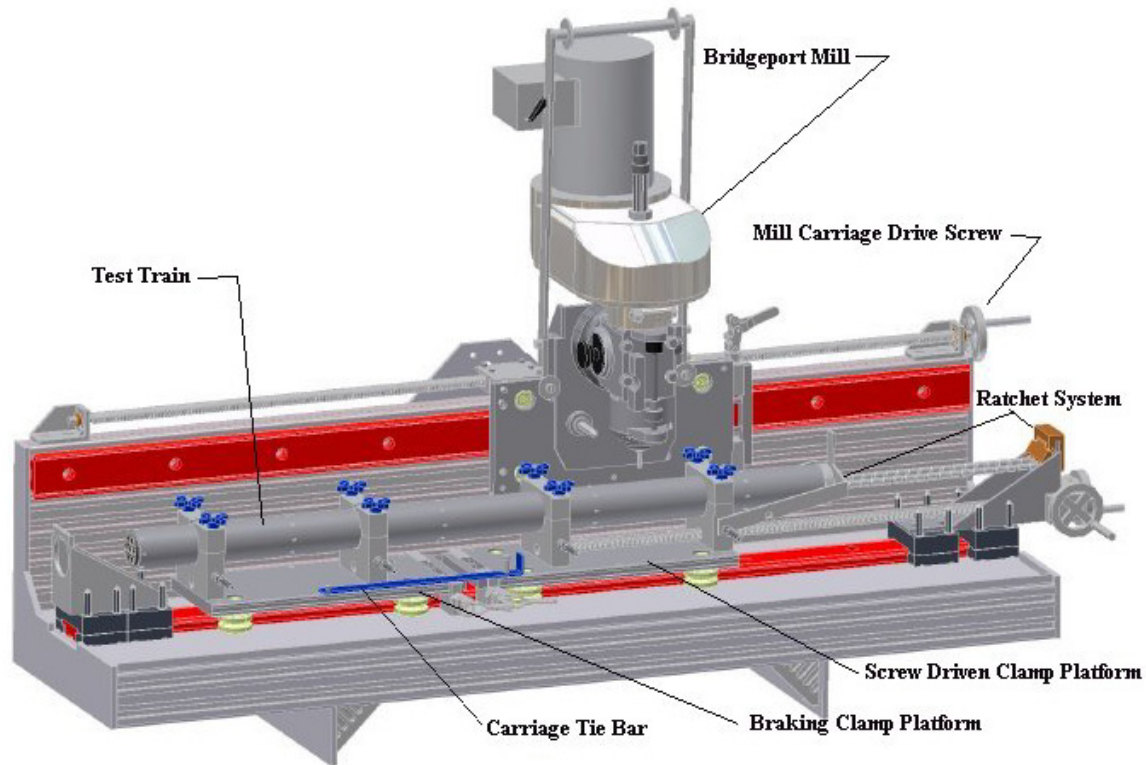


Figure 1. AGC-1 disassembly table design.

To address the need for a transportation package for moving the samples from MFC to IRC, a commercially available DOT-7A drum with 3 inches of lead shielding (see Figure 2) was identified as an appropriate shipping container for the graphite components. The dose rates were compared to those used for ECAR-469, Radiological Control Recommendations for Post Irradiation Examination of Activated Graphite Performed at IRC, which covers handling of these materials in the IRC. The 3-inch lead shielding was concluded to be adequate. This design also includes an internal basket for cushioning and maintaining orientation of the sample shipping tubes and the center stack receiver.

Because the weight of the shielded drum is 3,600 lb, and the workspaces at IRC are limited, a pallet with a lift arm for holding the 500 lb lid was conceptually designed, as shown in Figure 3. The pallet with lift arm allows the drum to be handled with a pallet jack rather than a forklift, which would require more space to maneuver. This proposed design is described in TEV-872, "AGC-1 Shielded Drum Transport System," which was reviewed by both IRC and HFEF personnel.

A statement of work for the pallet and lid lift system to

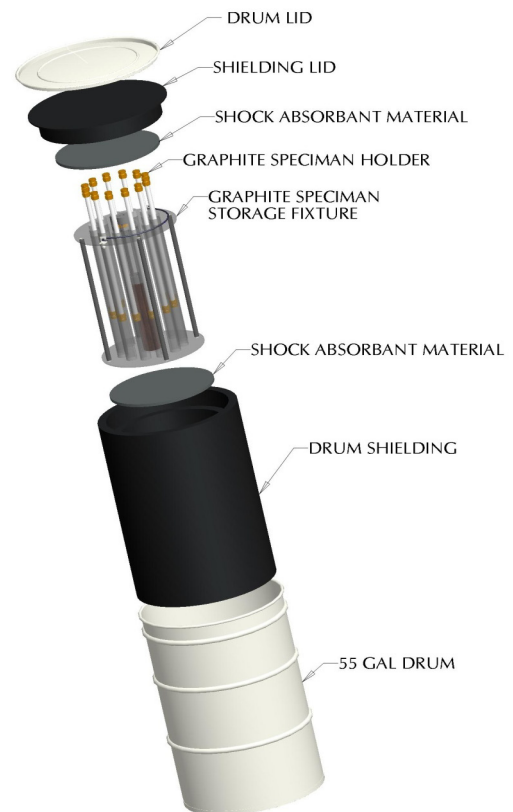


Figure 2. Conceptual model of the AGC-1 shielded drum and contents.

be fabricated by an external hoisting and rigging vendor was prepared and submitted for approval.

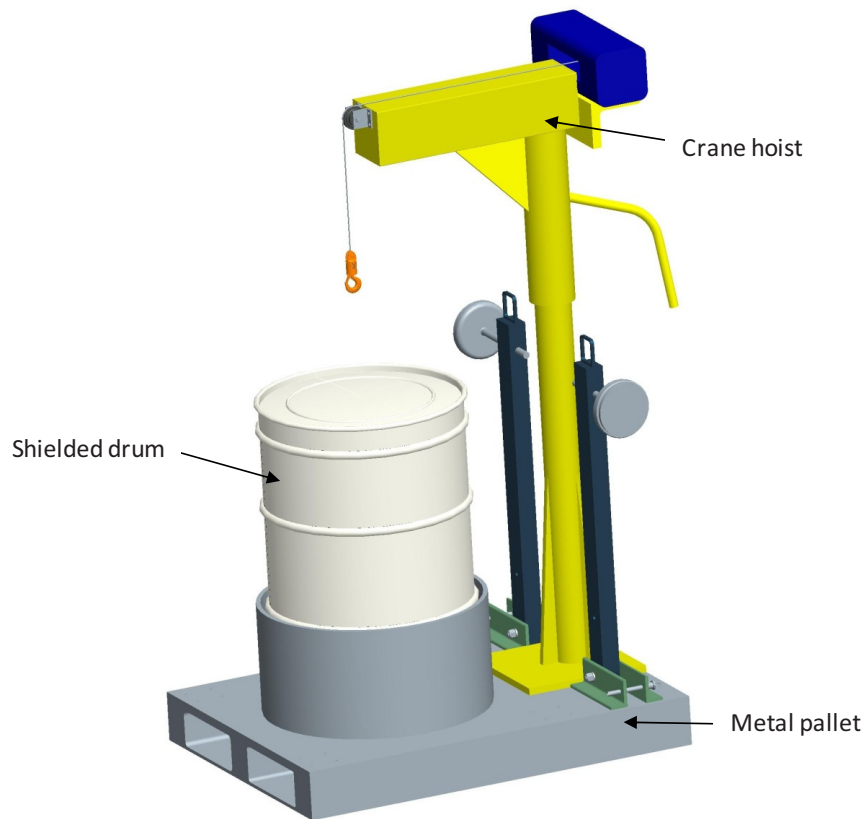


Figure 3. Conceptual Design for Shielded Drum and Integral Lid Hoist

To maintain IRC lab C-20 laboratory as a nonradiation area (less than 5 mR/hr general body fields), shielded sample storage was designed. The design is a shielded box with supplemental shielding for individual sample storage. A commercial lead-shielded storage cabinet was purchased and supplemental rotary “lazy Susan” steel storage sectors were fabricated to fit inside the cabinet. These rotary sectors can be positioned to allow only four samples to be accessible at one time to minimize personnel exposure. The primary components are 2.25-inch thick carbon steel discs with recesses machined to hold multiple sample capsules. When assembled, at least 288 samples can be stored with minimal exposure potential. The design is shown on drawings 601163 and 601164 and an excerpt is shown in Figure 4.

A fixture was also designed to minimize contamination during handling of the individual samples in the HRA by allowing the samples to be transferred directly from the graphite body into tubes that contain the samples inside the shipping drum. When used with the transparent shipping tubes, this manual rod-out tool will allow the condition of the samples to be evaluated through the HRA window, while they are being prepared for shipping. Dose rates from the samples and the graphite body will be evaluated at the time the shipping tubes are loaded, providing a decision on ALARA controls for bagging the tubes out of the HRA into the shipping drum.

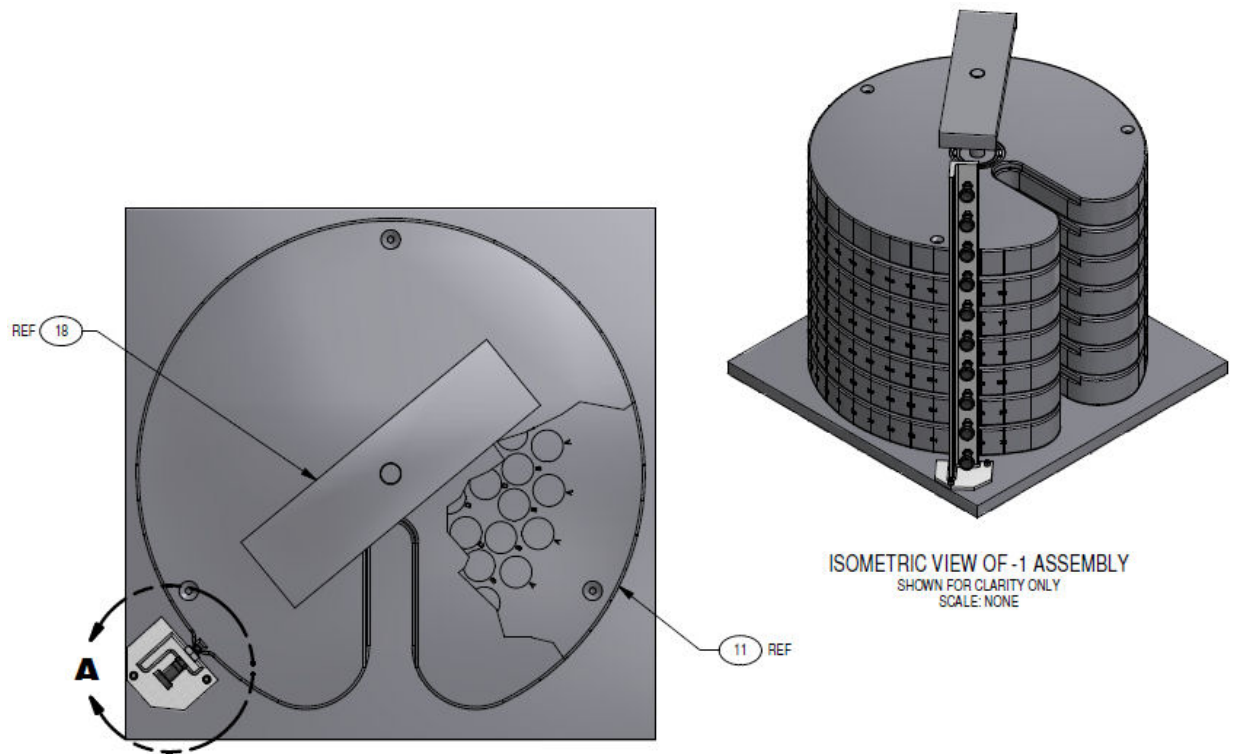


Figure 4. Lazy Susan Storage Component Design

3. PROCUREMENT AND FABRICATION

A work request was submitted to the INL Machine Shop to fabricate the disassembly table. This unit could be used to demonstrate the system feasibility and, through the MFC 3-phase qualification process, become the operational tool for disassembly. Materials were procured, and the table was assembled up to the stage where initial testing can be performed, following development of a qualification test plan. A mockup AGC-1 experiment was previously fabricated using polymer surrogates for the graphite samples and stainless steel for the pressure boundary. This mockup will be used to verify the sectioning method, as well as the steel pressure boundary removal.

The mill head was identified as an excess component that was available at the North Holmes Laboratory. It is a common Bridgeport mill head that was mounted to a bracket to allow remote installation in the HFEF cell.

The primary components for clamping and manipulating the experiment components were fabricated using standard structural components and custom-machined clamping tools. The clamping and rod-out components for center stack removal were fabricated, but the multiple compartment receiver tube has not yet been completed.

The thermocouple coring tools were designed, fabricated and tested in a manual mode and found to be acceptable for further modification for remote use.

The shipping drum was procured with assistance from the INL Packaging and Transportation department, and was received from Bull Run Metal in May. Discrepancies in vendor documentation were resolved as “use as is” and the drum was accepted for use in August.

The shielded storage cabinet was received in April, and the lazy Susan design was approved and fabrication initiated in March. The fabrication for the primary components was completed in July, and the materials shipped to WestOne storage in preparation for powder coating to make decontamination easier and eliminate rusting.

The fixture for transfer of the samples to the shipping tubes in the HRA was designed and fabricated. Modification of the current design will be required to accommodate a larger shipping tube than originally envisioned.

4. ACTIONS TO BE COMPLETED

Final plant drawings will be completed to provide an official basis for unreviewed safety question (USQ) and facility review prior to testing and installation.

A Qualification Test Plan will be developed and approved for testing and remote qualification of the disassembly table and associated tools at the MFC-765 FCF mockup shop.

An Installation and Test Plan will be developed and approved for installation and certification of the disassembly system in the MFC-785 HFEF main Hot Cell and Hot Repair Area.

A disassembly procedure Operating Instruction will be developed and approved to provide guidance to operations personnel during the disassembly task.

The shielded shipping container pallet and lid-lifting unit will be procured from an outside vendor.

The lazy Susan components will be powder coated by a local vendor, assembled at North Holmes Laboratory and installed in the storage cabinet.

The equipment will be installed and tested by the end of FY-11.